Enhanced four wave mixing in slow light GaInP photonic crystals waveguides and 40 Gbit/s transmission assessment

Kevin Lenglé, Laurent Bramerie, Mathilde Gay, Jean-Claude Simon, Sylvain Combrié, Pierre Colman, Alfredo de Rossi

Enhanced four wave mixing in slow light GaInP photonic crystals waveguides and 40 Gbit/s transmission assessment.

K.Lengle[1], L.Bramerie[1], M.Gay[1], J-C. Simon[1], S.Combrie[2], P.Colman[2], A. de Rossi[2]

1. Université Européenne de Bretagne (UEB), laboratoire CNRS-Foton (UMR 6082)/Université Rennes1, ENSSAT, BP 80518, 22305 Lannion Cedex, France

2. Thales Research and Technology, 1 Avenue. A. Fresnel, 91767 Palaiseau, France

Photonic crystals waveguides (PhCWG), based on III-V materials are promising for high density integration of optical circuits. In slow light transmission regime, the local field enhancement scales inversely with the group velocity, thus decreasing the threshold of intensity-dependant nonlinear effects such as Kerr effects [1, 2]. We report here a comparison of four wave mixing (FWM) in III-V photonic crystals waveguides in standard and slow light structures.

The samples were fabricated at Thales TRT and consist in a 1mm long self-standing membrane of GaInP. More details of structure can be found here [3]. Fig. 1 a) and c) presents the group index evolution versus the wavelength measured by phase-shift technique [4] of the two PhCWG considered in this paper showing a sample with a standard transmission regime and a sample with a slow light transmission regime.

Fig. 1 b) and d) present FWM efficiency maps as a function of pump wavelength and spectral detuning in the degenerate FWM pump probe experiment (repetition rate of 500 MHz with pulse width of 100 ps).

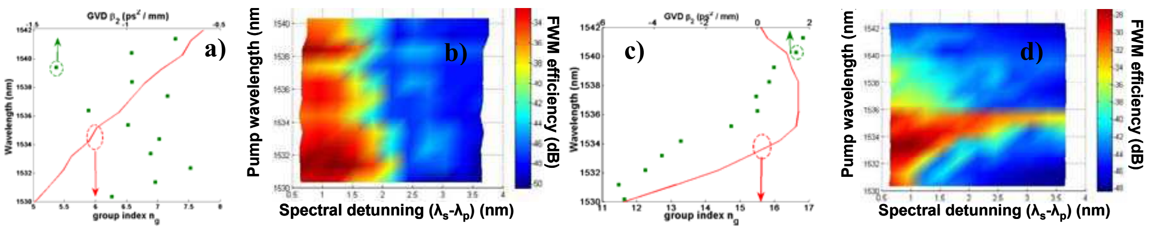

Fig. 1 Group index profiles of studied PhCWG and associated FWM maps.

Results show a maximum of FWM efficiency of -32 dB for the standard PhCWG and -27 dB for the slow light one. We have a maximum spectral detuning of 2 nm in the standard PhCWG and of 3.5 nm in the slow light case. However the slow light case looks less tolerant to pump wavelength because of 2nd order dispersion.

We then analyze the possibility to transmit a 40 Gbit/s RZ signal in slow light sample at a wavelength of standard transmission regime (1530 nm) and slow light transmission regime (1534 nm). Fig.2 a) and b) present the output spectra (res. 0.07nm) and the fiber-to-fiber transmission (res. 0.01nm) showing higher transmission perturbations in the slow light regime, leading to spectral deformations. Fig 2 c) shows bit error rate assessment in both regimes showing no penalty in the standard regime and a 1 dB penalty (at Bit Error Rate of 10^{-9}) in the slow light regime attributed to the transmission perturbations on Fig.2 b).

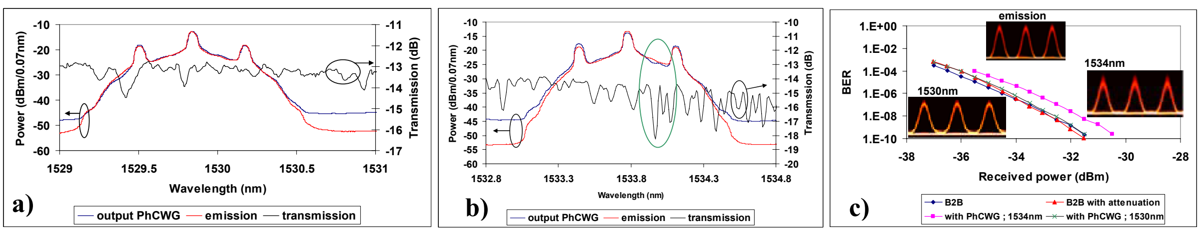

Fig. 2 Output spectra (a,b) and BER measurement (c) at ~1530nm and ~1534nm.

In this paper we have demonstrated the enhancement of FWM conversion efficiency and bandwidth in a PhCWG in a slow-light regime. The possibility to transmit a 40 Gbit/s RZ signal with only 1 dB penalty in this regime gives opportunity to optical demultiplexing by FWM.

References

[1] C. Husko, S Combrie, Q. Tran, F. Raineri, C.W. Wong, A. de Rossi, "Non trivial scaling of self-phase modulation and three photon absorption in III-V photonic crystal waveguides", Opt. Exp., **17**, No25, 22442 (2009)

[2] T. Baba, "Slow light in photonic crystals", Nature Photonics, 2, 465, August 2008.

[3] Q.V Tran, S. Combrie, P. Colman, A. de Rossi, "Photonic crystal membrane waveguides with low insertion losses ", App. Phys. Lett., **95**, 061105 (2009)

[4] S. Combrie, A. De Rossi, L. Morvan, S. Tonda, S. Cassette, D. Dolfi, A. Talneau, "Time-delay measurement in singlemode, low-loss photonic crystal waveguides", Electron. Lett. **42**, 86 (2006).